

App. No. 10/693,283
Office Action Dated June 3, 2005

REMARKS

Favorable reconsideration of this application is requested in view of the above amendments and the following remarks. Claim 12 is hereby amended. No new matter has been added. Claims 12-14 are pending.

Claims 12 and 14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Skinner et al (U.S. Patent Application Publication No. 2002/0068132 A1), optionally considering Takagi et al (U.S. Patent No. 4,395,465) or Kawawake et al (U.S. Patent No. 6,535,362 B2), further in view of Kawawake et al (U.S. Patent No. 6,245,450 B1) or Nishioka et al (U.S. Patent No. 5,648,885). Applicants respectfully traverse this rejection to the extent it is maintained.

Claim 12 is directed to a method for manufacturing a magnetoresistive element. Claim 12 recites, among other features, that the steps are carried out in the listed order from (a) to (e), so that the claim requires two heat treatment steps, namely a first heat treatment of the underlying film at 400°C or more in step (b), and then heat-treating the substrate and the multi-layer film at 330°C or more in step (e).

The features of claim 12 provide advantages, such that the first heat treatment may improve variation in wiring resistance and may reduce distortion in the underlying film, and both heat treatments thereby can improve the overall magnetoresistive (MR) characteristics. (See for example page 6, lines 12-35.) For example, the heat treatment step (b) is performed at 400°C or more for the purpose of reducing distortion. The MR characteristics, however, may be degraded under heat treatment at such high temperature. Thus, the first heat treatment of step (b) may be carried out before step (d) of forming the MR element. Further, by carrying out step (b) before step (c) of decreasing roughness by irradiating with an ion beam, the advantageous effect of improving the MR element surface, which may have been degraded by step (b), can be obtained. (See for example page 11, lines 7-23.) Skinner et al., however, does not disclose or suggest the features required by claim 12.

Skinner et al. is directed to improving a roughness of a permalloy underlying film by irradiation of a gas ion cluster so as to obtain a smoothed surface. On the smoothed surface, an MR element is formed, in an attempt to improve characteristics of the element. Skinner et al. discloses formation of a giant magnetoresistive (MR or GMR) element, including two ferromagnetic films separated by third non-magnetic layer. (See for example paragraph [0004-0005].) The cited reference further mentions the benefits of smoothing GMR devices and a gas

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cluster ion beam process to obtain a polished film. (See for example paragraphs [0009] and [0030].) As noted in the Office Action, Skinner et al. fails to disclose or suggest any heating process. Moreover, Skinner et al. does not teach or suggest the two heat treatment steps (b) and (e) or the specified order thereof. For at least these reasons, claim 12 is distinguishable from Skinner et al.

None of the secondary references provide what is missing from Skinner et al. Particularly, the other four cited patents disclose that MR characteristics are improved by heat treatment at 80°C to 350°C after formation of the film. Such heat treatments disclosed may correspond with the second heat treatment of step (e) in claim 12. The cited references, however, do not disclose or suggest any of the first heat treatment step (b), that two heat treatment steps are required, steps (b) and (e), or the recited order of the two heat treatment steps with respect to the other steps (c) and (d). For example, Takagi et al. simply mentions self-heating effects of ionized cluster beams. (See for example col. 2, lines 58-62.) Further, Kawawake et al. ('362) simply mentions a heat treatment of about 200°C and after the surface condition of the film was improved. (See for example col. 13, lines 34-52.) As another example, Nishioka et al. discloses annealing being at temperatures 80°C, 100°C, 140°C, 160°C, 200°C, and 250°C. Furthermore, Kawawake et al. ('450) simply discusses a heat treatment of 150°C to about 350°C after the film is formed. Thus, the cited references do not disclose or suggest any of the first heat treatment step (b), that two heat treatment steps are required, steps (b) and (e), or the recited order of the two heat treatment steps with respect to the other steps (c) and (d). For at least these reasons, claim 12 is distinguishable from any combination of Skinner et al, Takagi et al, Kawawake et al ('362), Kawawake et al ('450), and Nishioka et al.

As noted above, the claimed invention provides the first heating step (b) performed before the step (d) of forming the MR element. After step (b), step (c) of decreasing the roughness is performed before step (d). As further noted above, such ordering of steps provides an underlying film in good condition for forming the MR element thereon. The MR element may then be formed with improved MR characteristics, while employing the step (e). That is, improved MR characteristics can be obtained at a higher degree compared to the single heat treatments disclosed by the prior art, because the substrate and the underlying film have been subjected to the first heat treatment step (b).

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Therefore, Applicants respectfully submit that there is no reasonable suggestion or motivation in any of the cited references, either alone or in combination, to lead to the features of claim 12. Furthermore, there is no reasonable expectation of success in any of the cited references that would arrive at the advantages enjoyed by the features of claim 12, namely the two heat treatment steps and their recited order with respect to the other process steps. Accordingly, Applicants respectfully submit that claim 12 and dependent claims 13-14 are allowable over the cited references, and are not obvious.

Favorable reconsideration and withdrawal of the rejection are respectfully requested.

Claim 13 is rejected under 35 U.S.C. 103(a) as being unpatentable over Skinner et al, optionally in view of Kawawake et al ('362) or Takagi et al (above), and in view of Kawawake et al ('450) or Nishioka et al (above) as applied to claims 12 and 14 above, and further in view of Takagi et al. (above). Applicants respectfully traverse this rejection to the extent it is maintained.

Skinner et al. has been discussed above in detail, and does not teach or suggest the features required by claim 12. None of the other prior art cited provides what is missing from Skinner et al. Claim 13 depends upon claim 12 and includes the limitations recited therein. Thus, claim 13 is allowable over any combination of the cited references for at least the same reasons with respect to claim 12. Applicants do not concede the correctness of the rejection. Accordingly, Applicants respectfully submit that claim 13 is allowable over the cited references and is not obvious.

Favorable reconsideration and withdrawal of the rejection are respectfully requested.

In view of the above, Applicants believe that the pending claims are allowable. Favorable reconsideration in the form of a Notice of Allowance is requested. Any questions regarding this communication can be directed to the undersigned attorney.

Respectfully Submitted,

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